Resource Action: EWG - 31 **Task Force Recommendation Category: 1**

Warm Water Species Habitat Enhancement in Lake Oroville

Date of Field Evaluation: N/A

Evaluation Team: Eric See and Troy Baker with input from Woody Elliott

Description of Potential Resource Action:
This Resource Action is designed to increase and/or improve the structural complexity of the Lake Oroville fluctuation zone to benefit warm water game fish such as black bass and channel catfish that use these areas for spawning and rearing. This would be accomplished by constructing artificial reefs using boulders, weighted pipes, riprap, Christmas trees, logs and other large woody debris, and by planting flood tolerant vegetation such as willow trees, button bush, and cattails, as well as possibly planting annual grasses during the drawdown period. Department of Water Resources (DWR) has been involved in a similar program continuously since 1993, and several other projects were periodically conducted prior to this time. This project would be implemented using an "adaptive management" approach, and would occur in 5-year phases. This Resource Action describes the first 5-year phase.

The following resource actions are either similar to or directly related to the proposed measure:

- EWG-50, that is aimed at maintaining the coldwater fishery in Lake Oroville.
- EWG-68B, that is aimed at building the riparian habitat in the Lake Oroville fluctuation zone.
- EWG-26, that is aimed at improving habitat in a similar manner in Thermalito Afterbay.
- EWG-28, manage water levels in the Thermalito Afterbay aimed at protecting nesting and rearing warm water species (i.e., bass).

Nexus to Project:
- Water level fluctuations hinder the establishment of rooted aquatic vegetation, which reduces cover for game fish and may lead to reduced year-class strength.
- The existing Vegetation Retention Areas, which provide large woody debris habitat for the Lake Oroville fishery, have degraded over time and are in need of maintenance and/or replacement.
- The Department of Parks and Recreation (DPR) has requested the removal of existing tire-reef fish habitat because of concerns regarding mosquito breeding habitat.

Potential Environmental Benefits:
- The primary intended benefit is increasing the habitat complexity in Lake Oroville. This increases the amount of escape cover for juvenile game fish and will reduce the

rate of predation, which can result in increased year-class strength. In addition, the total amount of surface area for periphyton attachment is increased which may increase levels of productivity, benefiting both juvenile game fish, and forage fish production which can also enhance adult warm water and coldwater game fish populations.

- Black bass prefer nesting near macrocover such as rocks, stumps, sunken trees and other large woody debris, submerged brush, etc.
- Brush shelters and mature trees reduce the erosive effects of wave action, decreasing impacts on game fish nests, as well as reducing reservoir turbidity in the habitat enhancement areas.
- Aquatic and terrestrial wildlife (e.g., amphibians, reptiles, birds) also derive benefits from an increase in the structural complexity of the fluctuation zone through increased cover and foraging.
- Reduced mosquito breeding habitat – This Resource Action may include replacing existing tire reef fish habitat with structures that do not have the same water retaining characteristics, thereby reducing mosquito breeding habitat at Lake Oroville.
- Enhanced aesthetics by increasing the amount of trees in the reservoir fluctuation zone, as well as annual grasses if deemed feasible
- These projects are very well received by the local public and generate a significant amount of positive public relations for DWR

Potential Constraints:
Potential constraints associated with this Resource Action could include:

- Navigational/swimming hazards
- Aesthetic concerns with certain materials (e.g., reefs made of used tires considered unsightly)
- Site location (some of the better sites may be located in remote-access areas that are logistically difficult and more costly)
- The extent and duration of water level fluctuations will affect the survival of rooted vegetation and thus limit the areas where they can be planted

Existing Conditions in the Proposed Resource Action Implementation Area:
Lake Oroville is a large two-story (both warm water and coldwater fisheries) reservoir with 167 miles of shoreline at its full pool elevation of 901 ft, with a surface acreage of 15,810. The reservoir can fluctuate more than 100 feet during the course of a “normal" year, with about 250 feet being the most it has ever fluctuated. Annually, the lowest levels occur in the fall, the highest in late spring. These large water level fluctuations, in addition to the reservoir’s steep slopes and poor soils, hinders the establishment of rooted aquatic vegetation in the littoral zone, and restricts the encroachment of terrestrial vegetation into this area (Figure 1). The loss of this cover, which provides spawning and nursery habitat for warm water fishes, is related to observed declines in standing crops of centrarchid species (e.g., black bass, sunfish) as a result of reduced food availability and higher predation on young-of-year fishes (Brouha and Von Geldern 1979).

When Lake Oroville was constructed, the vegetation was removed from the hillsides that were to become inundated, except for selected areas referred to as “Vegetation Retention Areas” (Figure 2). In these areas, large woody debris such as trees and logs were left to provide macrocover for reservoir fisheries. Eighteen areas were designated totaling over 1100 acres. These areas have degraded over time, due to wood decaying processes, along with wave action, water fluctuations, and the rusting of many of the anchor cables used for the log structures.

Although centrarchid cover is limited at Lake Oroville, centrarchid spawning substrates such as clay, sand, and small gravel are relatively abundant so substrate enhancement is unnecessary for these species. However, this is not the case with channel catfish spawning habitat. Channel catfish prefer to spawn in ”cave-like” sites in undercut banks, large root wads, log jams, under large rocks, and other protected sites. Although the extent has not been documented, the degradation of the Vegetation Retention Areas has resulted in the loss of some of this habitat.

During the 1980s, the Department of Fish and Game (DFG) and DPR, along with several fishing organizations, constructed reefs made of discarded tires in several coves around Lake Oroville (Figure 3). Although these reefs are an effective, durable, and inexpensive type of fish habitat, providing habitat for centrarchids as well as channel catfish, they also have a tendency to retain water when the lake recedes, which provides suitable habitat for mosquito breeding. DPR has requested that these reefs be replaced with fish habitat that will not create the same problem, such as large woody debris, brush shelters, and willow trees.

Design Considerations and Evaluation:

This Resource Action involves 3 different types of habitat enhancement projects, brush shelters, flood tolerant trees and annual grasses (if deemed feasible), and channel catfish spawning structures.

<u>Brush shelters</u>
Brush shelters are reefs that are constructed on the lakebed within the reservoir fluctuation zone (Figures 4 and 5). They consist of various materials including discarded Christmas trees, trees/brush cut from the upland areas adjacent to/near Lake Oroville, and artificial habitat structures made of plastic. The brush shelters are anchored to the lakebed using steel fence posts, concrete blocks, or other suitable materials, to keep the brush shelters from floating away when inundated during the spring and summer. Typically brush shelters are built as separate units covering 150 to 400 ft^2 of lakebed, and they are installed in clusters in the back of coves with shallow sloping banks. These are common spawning areas for black bass, particularly largemouth bass, so these brush shelters would be located to increase spawning success (nest protection from wave action, satisfy bass preference for spawning near structure), as well as increase post-spawn survival of juvenile bass. Projects should be targeted in the elevation range between 775’ to 875’ to provide spawning benefits at a variety of ranges, and because during the summer and

fall, young bass inhabit a zone down to a depth of about 25', so enhancement projects conducted in this range will provide benefits to bass when lake levels are in the range of about 800' to 900'. An evaluation of site specific conditions such as slope, soil type, exposure, access, and other factors (cultural resources, existing trees, geologic formations, etc.) will determine the specific placement and types of structures. Current locations identified (others may be identified):

- Cove near the Spillway (Christmas trees)
- Parrish Cove (Christmas trees, and/or cut trees and brush)
- Miners Ranch Area of Bidwell Cove (Christmas trees, and/or cut trees and brush, and/or artificial structures)
- Vinton Gulch (Christmas trees)
- Near Loafer Creek Group Campground (Christmas trees, and/or cut trees and brush, and/or artificial structures)
- Coves near Foreman Creek Boat-in Campground (Christmas trees, and/or cut trees and brush, and/or artificial structures)
- Cove south of State Service Ramp, across from Loafer Creek Picnic Area

Construction of brush shelters would be implemented on an annual basis, and the target amount would be the equivalent of approximately eighty 10'x20'x3' brush shelters, which would enhance approximately 2 acres of lakebed. It is difficult to assign specific sizes and amounts with brush shelter projects because they differ so much in their design based upon the materials used and the conditions at the site. However this target should provide an approximate annual goal for these projects.

These projects are very popular with the local public. Many different local groups have volunteered to assist DWR in its current brush shelter activities, including the Boy Scouts of America, local fishing clubs, schools, and private citizens. This Resource Action will continue this tradition of working with the public on these projects, and the extent of the projects in a given year may be expanded based upon the level of local volunteer involvement.

Flood Tolerant Trees

Native trees such as willow (*Salix spp*. and buttonbush (*Cephalanthus occidentalis*) would be planted in the fluctuation zone in the 850'–890' elevation range. These trees can survive periodic inundation as well as dry conditions found in the fluctuation zone in during the summer and fall, particularly if they survive the first 1 or 2 years and establish a deep root system. When successfully established, these trees provide large amounts of structural complexity over a long period of time and have the added benefit of enhancing the aesthetics of the reservoir fluctuation zone (Figure 6). As an example, many of the willows planted by DFG during the 1970's are now over 20' high and continue to grow, increasing the amount of cover provided. The 850' elevation is the lowest these trees should be planted because any planted below this elevation stand the possibility of being inundated year-round on a wet year due to the flood storage operations at the lake. This is why very few trees have ever survived long term at lake Oroville below this elevation, and even those trees are not found lower than about 840'.

The trees planted would primarily come from cuttings taken from existing trees in the fluctuation zone of Lake Oroville, because they are located close by, and are species that have proven abilities to survive in the harsh environment of the reservoir fluctuation zone. Two types of planting techniques would be used, planting unrooted cuttings, and planting rooted cuttings. Unrooted cuttings, or slips, would be cut and planted directly in the lake bed prior to the slips drying out. With rooted cuttings, the cuttings are planted in a nursery and grown for a period of time, typically a year, and then transported to the lake for planting in the fluctuation zone. Rooted cutting are more expensive, however they have a higher chance of survival (approximately 5%-15% survival) than slips (approximately 1%). This Resource Action would utilize both techniques.

One of the most important factors for success in establishing flood tolerant trees in the fluctuation zone is survival during the first 1-2 years after planting, and this is usually related to lack of soil moisture. Most of the fluctuation zone is lacking in summertime water sources (streams, springs) in areas that are ideal for warm water fish habitat enhancement (back of coves, shallower slope, 850' – 890' range). In addition, this zone is subjected to several months of very hot and dry conditions from mid-July through mid-October, and it is during this time that most newly planted trees will not survive. Under these conditions, Lee and Gleason (1989) recommend developing an irrigation plan prior to planting, and this would be a significant component of this habitat enhancement activity. Irrigation techniques could entail pumping water to the trees from Lake Oroville or tributaries (or diversions in the case of tributaries), piping water from developed water sources at campgrounds and picnic areas, pumping water from existing flumes (Figure 7) along the shoreline such as the Miocene Canal in the Lime Saddle Area, and the Oroville Wyandotte Irrigation District (OWID) canal on the South Fork Arm, or trucking water to the enhancement areas. Drip systems would be constructed to deliver the water to the trees most efficiently, either tapping directly into a developed system, or installing water tanks at the top of the system. Based on previous experience at Lake Oroville, and depending upon the specific site conditions of slope, soil type, exposure, and access, a target range of 300 to 500 trees per acre should be used. The trees would be watered once every 10 days, and would average about 1 gallon per tree per day for a range of 2700 to 4500 gallons (less than .015 acre-feet) of water per acre annually.

Current locations identified for construction of these systems (others may be identified):

- Cove near the Spillway Boat Ramp (tap into existing developed water system)
- Near Bidwell Campground (tap into existing and possible future developed water system)
- Near Loafer Creek Group Campground (tap into existing developed water system)
- Miners Ranch Area (divert existing creek)
- Parrish Cove (tap into existing developed water system from campground and/or Lime Saddle Boat Ramp, or pump from Miocene Canal)
- ~12 coves along 7 miles of the South Fk. Arm (pump water from OWID canal located immediately above the high water mark of Lake Oroville, as shown in Figure 6)
- Cove south of State Service Ramp, across from Loafer Creek Picnic Area

An enhancement area with a minimum of 1 acre would be needed to justify the cost for each of these systems, and a cost-benefit analysis would be conducted for each location. Rooted trees would primarily be used with irrigation systems because of their increased chance of survival improving the cost-benefit ratio. One irrigation system per year would b constructed, and approximately 1000 trees would be planted.

In addition to planting rooted trees in irrigated areas, slips would be planted in large quantities in various locations. A 10-person work crew is capable of cutting and planting several thousand cuttings per day, so although survival is much lower, this method will result in at least some survival at a lower cost (~60%-80%). Approximately 10,000 slips would be planted on an annual basis.

Current locations for willow and button bush slip planting (others may be identified):

- Nelson Bar Area
- Miners Ranch Area
- South Fork Arm
- Foreman Creek Area
- Near Loafer Creek Group Campground
- Parrish Cove
- Vinton Gulch
- Cove south of State Service Ramp, across from Loafer Creek Picnic Area

Annual grasses that germinate in the fall and grow during the winter could be planted to provide microcover for juvenile fish (Lee and Gleason 1989; Strange et al. 1982). These include Wimmera #C2 ryegrass, *Lolium rigidum*; lana vetch, *Vicia dasycarpa*; and Blando brome, *bromus mollis*; and/or others, could be planted in small 1-5 acre areas with hand spreaders, or in larger areas (20-50 acres) by airplane. Use of fertilizers and disking may be conducted to increase success. This project would need to be reviewed for its potential impacts on native grasses in the Lake Oroville area. A similar project has been discussed in the Land Use Workgroup as an enhancement to the barren fluctuation zone for aesthetic purposes, so these projects could be combined if desirable.

Possible locations for grass seeding (others may be identified):

- Cove near Spillway Boat Ramp
- Potter Ravine
- Foreman Creek Area
- Loafer Creek Area

<u>Channel Catfish Spawning Structures</u>

As previously mentioned, channel catfish prefer to spawn in secluded,”cave-like” locations. This project would primarily involve the placement of 3-4 ft. sections of 9-18 in. diameter concrete and PVC pipe, which makes excellent spawning habitat. Other materials may be substituted for concrete and PVC pipe based on availability, including scrap pieces of culvert, steel pipe, buckets, and other discarded items found around the Oroville Field Division. Rock rubble and other materials that create similar cavities may

also be used. These “pipe-caves” would be placed in the same areas and elevations identified for brush shelters, as well as several of the coves along the South Fork Arm, which is the most popular channel catfish fishing area at Lake Oroville. Due to the territorial behavior of male channel catfish during the spawning season, the pipe-caves would be placed at least 40 ft. apart to reduce fighting among males (Lee and Gleason, 1989). In order to prevent the creation of mosquito breeding habitat, all of the pipe-caves would be installed in a manner that did not result in standing water as the lake is drawn down, as currently happens with the tire-reefs. The pipe would be oriented for the water to drain out and/or holes could be drilled for additional drainage.

A target of 100 3-4 ft. pipe-caves would be installed each year, which would cover approximately 4 acres of lakebed.

Rock Reefs

Reefs made of boulders, rip rap, or other rubble material could be constructed to increase the amount of structure in the fluctuation zone. These reefs would be located in the same areas identified for brush shelters, and would be designed to provide the maximum amount of surface area and interstitial spaces for juvenile black bass cover, as well as “cavelike” channel catfish spawning habitat. These reefs are very long lasting, and do not have the brush shelter potential of breaking apart and floating away. The high cost of transport of these rubble materials would be a limiting factor in their use, however this project will be considered as an alternative to brush shelters if “waste” rubble becomes available in the local area.

Project Summary

The following is a summary of the projects in this Resource Action, they would be implemented annually over a 5-year period, at that time an evaluation for continuing this Resource Action for another 5 years would be considered along with potential alterations. These are estimates and may vary ±15%)

80 brush shelters
1000 rooted willow and/or buttonbush trees
10,000 willow and/or buttonbush slips
1 Irrigation System
Planting of Annual Grasses (needs to be coordinated with other Resource Actions)
100 Channel Catfish Spawning Structures
Construction of rock reefs if waste material can be acquired (number of reefs will be based on amount of available material, total would be similar to that of brush shelters)

Environmental permitting requirements may include:

CEQA

DFG 1601
ACOE 404
CWA 401

A monitoring program of the effects on the fishery could include springtime snorkel surveys and/or electrofishing to assess fish species composition, abundance, and size structure in the habitat enhancement areas. This would be used to confirm utilization of these projects by the target fish species such as black bass and channel catfish, and better hone the planning and implementation of future projects (brush shelter design, pipe-cave design, site location, etc.) Fish population monitoring could also be conducted to identify the overall effect on the fish production, however these analyses require a much higher level of effort and are more expensive, possibly exceeding the cost of the enhancement projects. This monitoring could be incorporated into Lake Oroville fishery monitoring for other Resource Actions or studies by other agencies.
Monitoring the projects themselves would involve recording the date of implementation and location of the projects (structures, grasses, trees, etc.) and then checking them over time. Periodic revisions in structure design may be necessary to increase their durability and/or effectiveness. Survival of willow trees and amounts of annual grasses would be recorded to monitor success in the various areas and this information will be used to identify better methods and sites for future plantings.

Synergism and Conflicts:

Synergism and Conflicts:

Synergisms could be created if this measure is planned in conjunction with other Resource Actions designed to enhance habitat for warm water species in Lake Oroville. This could include EWG-68B, which is aimed at building riparian habitat in the Lake Oroville fluctuation zone. EWG-68B could benefit warm water species nesting or rearing along the Lake Oroville shoreline. An additional measure related to this action is the proposal to plant willow trees in the Lake Oroville viewshed. Planting willow trees in Vegetation Retention Areas could result in a synergism with this measure. Riparian plantings would add structural complexity in the Lake Oroville fluctuation zone and thus provide a habitat benefit for warm water species. Concerns have been raised about the persistence of mosquito breeding habitat in tire-reefs because standing water is present after drawdown occurs. This measure is related to a resource action currently being considered by the Land Use, Land Management, and Aesthetics Workgroup designed to create an integrated, site-specific approach to pest management (LWG-6). Replacement of these tire-reefs with large woody debris and properly drained pipe-caves would reduce this mosquito habitat, thereby assisting with pest management. This Resource Action is synergistic with the development of a recreational fishery management plan since it would primarily benefit the Lake Oroville recreational fishery.

A conflict could occur with activities designed to eliminate noxious plants in the Lake Oroville fluctuation zone (EWG-74B). Vegetation growth in the fluctuation zone adds temporary structural complexity to lake substrates following inundation. Elimination of

noxious vegetation in the fluctuation zone during dewatered periods would result in a net decrease in available rooted vegetation and thus limit habitat complexity when lake levels have risen. In addition, because these projects are designed to increase the amount of structure in the fluctuation zone, a certain amount of navigation and swimming hazards may be created. This would be kept in mind when determining the location and design of the structures to be installed; certain projects (e.g., brush shelters, rock rubble) may not be implemented near swimming areas or high boat traffic areas of the lake. Warning buoys and/or signs would be considered. Due to the location and nature of these projects, impacts to cultural resources may occur so consideration of this would be an integral component of the planning. These projects are flexible enough in their design and location options to allow avoidance of cultural resource impacts, and may even be able to assist in the protection of these resources by concealment of the resources themselves and/or construction of barriers to reduce vandalism and vehicular impacts (e.g. boulder installation). All of these projects will go through a formal archaeological review prior to implementation.

Uncertainties:

The main uncertainty associated with this Resource Action would be determining the level of success of the various projects. Monitoring may indicate increased fish utilization of these areas, however it will be difficult to determine if this is related to increased production, or a result of fish being attracted to these areas. In addition, the fluctuation regime, water temperatures, weather patterns, and many other environmental factors that are difficult to quantify may affect the numbers of fish in a given year and mask the impact of this Resource Action. Site locations may need to be changed based upon issues raised in the environmental permitting process, such as sensitive cultural resources.

Cost Estimate (Annual):
80 brush shelters: $23,000
1000 rooted willow and/or buttonbush trees: $1500
10,000 willow and/or buttonbush slips: $3000
1 Irrigation System (includes O&M): $3000
Planting of Annual Grasses (tentative): $500 – $5000?
100 Channel Catfish Spawning Structures: $3500
Monitoring: $3000 - ?
Rock Rubble: $10,000
Annual Total: $35,000 – $50,000 (with review after 5 years)

Recommendations:

This Resource Action has been reclassified as a Category 1, and should be considered as an alternative for mitigating the potential negative effects of project operations on warm water game fish at Lake Oroville. These projects are designed to strengthen year classes of centrarchid and ictalurid species in Lake Oroville which are very popular gamefish. Along with fishery benefits, these projects can enhance the aesthetic aspects

of the reservoir fluctuation zone, as well as provide benefits for terrestrial species by increasing the structural complexity in these areas. In addition, these projects are well regarded by the local public and provide the opportunity for outreach programs with local organizations such as the Boy Scouts of America, fishing organizations, and area schools.

Literature Cited:

Brouha, P. and C.E. Von Geldern. 1979. Habitat manipulation for centrarchid production in western reservoirs. pp. 11-17 *in* D.L. Johnson and R.A. Stein, editors. Response of fish to habitat structure in standing water. North Central Division American Fisheries Society Special Publication 6.

Lee, D.P. and E. Gleason. 1989. Warmwater reservoir fish habitat improvement techniques. California Department of Fish and Game, Inland Fisheries Informational Leaflet, Number 42. 29 pp.

Strange, J.S., Kittrell, W.B., and T. Broadbent. 1982. Effects of seeding reservoir fluctuation zones on young-of-year black bass and associated species. North American Journal of Fisheries Management, Volume 2, Number 4, pp. 307-315.

Figure 1. Lake Oroville Fluctuation Zone (Spillway Cove)

Figure 2 Vegetation Retention Area (McCabe Cove)

Figure 3. Tire Reefs (Miners Ranch Area)

Figure 4. Christmas Tree Brush Shelters (Miners Ranch)

Figure 5. Manzanita Brush Shelter (Spillway Cove)

Figure 6. Willow Trees (Miners Ranch Area)

Figure 7. O.W.I.D. Canal (South Fork Arm)